Conservation Agreement and Strategy for Graham's Beardtongue (*Penstemon grahamii*) and White River Beardtongue (*P. scariosus* var. *albifluvis*)

DEMOGRAPHIC MONITORING PLAN

Prepared by the Penstemon Conservation Team

State of Utah School and Institutional Trust Lands Administration
Uintah County, Utah
Utah Public Lands Policy Coordination Office
Utah Division of Wildlife Resources
Rio Blanco County, Colorado
Bureau of Land Management
U.S. Fish and Wildlife Service

March 2017

CONSERVATION AGREEMENT AND STRATEGY FOR GRAHAM'S BEARDTONGUE (*PENSTEMON GRAHAMII*) AND WHITE RIVER BEARDTONGUE (*P. SCARIOSUS* VAR. *ALBIFLUVIS*):

DEMOGRAPHIC MONITORING PLAN

Prepared by

The Penstemon Conservation Team

State of Utah School and Institutional Trust Lands Administration
Uintah County, Utah
Utah Public Lands Policy Coordination Office
Utah Division of Wildlife Resources
Rio Blanco County, Colorado
Bureau of Land Management
U.S. Fish and Wildlife Service

March 31, 2017

CONTENTS

FIGURES

This page intentionally blank

INTRODUCTION

In 2014, the Conservation Agreement Strategy for Graham's beardtongue (*Penstemon grahamii*) and White River beardtongue (*Penstemon albifluvis* [=*Penstemon scariosus* var. *albifluvis*]) was signed, and included a requirement that a long-term demographic monitoring plan will be developed and implemented (Penstemon Conservation Team [PCT] 2014). Specifically, the Agreement states that the conservation team will develop and implement a scientifically valid monitoring plan to capture range-wide variation in habitat, climate, and population processes (pg. 29).

This range-wide demographic monitoring plan was written by the interdisciplinary Penstemon Conservation Team Demographic Sub-committee and approved by the PCT. Implementation of this monitoring plan is expected to begin in May of 2017 (pilot year) and will continue for the duration of the conservation agreement. The results from the pilot year will be used to determine final monitoring, sampling, and field protocol methods. Changes to the plan may occur after initial pilot data are examined. The Vernal and White River Field Offices of the BLM will conduct the monitoring outlined in this plan. The full monitoring plan will be implemented in 2018 and is planned to be completed every other year after the 2018 field season. Throughout the life of the plan, changes in the strategy will be made when necessary (new information, etc.) and as approved by the PCT using principles of adaptive management. If any problems are identified during the monitoring, more intensive monitoring may be implemented in those areas.

This monitoring plan has three management goals incorporating three monitoring objectives (Elzinga *et al.* 1998) and will take place in two phases. Phase one will involve the monitoring of pollinators on study plants and counts of plant frequency along transects. Phase two will involve counts of fruits and seeds on the study plants. Because of the importance of outcross pollination for these species (Dodge and Yates 2009, McCaffery *et al.* 2014), we will also monitor pollinator abundance and diversity of flower visitors in each plot. Pollinators are often overlooked in demographic studies, and their importance in the conservation of rare plants is highly underestimated (Kearns *et al.* 1998). During the pilot year (2017) we will monitor 25 Graham's beardtongue plots and 25 White River beardtongue plots. Additional plots will be added or subtracted if needed, as determined by sample size calculations using the Sound Science Sample Size Calculator prior to year two (Unnasch 2009). In addition, the BLM-Vernal Field Office is implementing an Assessment, Inventory, and Monitoring (AIM) program in 2017 with the goal of long-term, field office-wide monitoring of plant communities. Many of these plots will fall within beardtongue habitat and will assist in the assessment of overall habitat conditions for each beardtongue species.

MANAGEMENT OBJECTIVES

This monitoring plan has four management objectives incorporating four sampling objectives. Management action will occur if identified thresholds are reached or exceeded.

1. ***Maintain the current range-wide population frequency of each beardtongue species so that overall frequency does not decrease by 10% or more over the next ten years.***

   Sampling objective: We want to be 90% certain of detecting an absolute 10% decrease in the frequency by life stage class (reproductive and non-reproductive) over the next ten years and are willing to accept a 20% chance that we will make a false-change error. Rationale: We chose 10% as a threshold because it represents a large proportion of individuals for these rare species.

2. ***Maintain the current pollinator abundance and diversity in at least 90% of all monitoring plots so that they do not decrease by 10% or more over the next ten years.***

   Sampling objective: We want to be 90% certain of detecting an absolute 10% decrease in pollinator abundance and/or diversity over the next the ten years and are willing to accept a 20% chance of making a false-change error. Rationale: We chose 10% as a threshold because little is known about the abundance of these pollinators.

3. ***Determine overall trend(s) in reproductive success and do not allow a 30% decrease in reproductive success over any 3-year period.***

   Sampling objective: We want to be 90% certain of detecting an absolute decrease of 30% decrease in reproduction over any 3-year period. We are willing to accept a 20% chance of making a false-change error. Rationale: We chose a 30% decrease, a relatively high level of change because decreases less than 30% could be attributed to inter-annual variation in reproductive success, and less than 50%, which would likely result in a reduced ability for the population to fully recover without long-term impacts to the species.

4. ***Monitor long-term climate data in beardtongue habitat.***

   Sampling objective: We want to determine variation in microclimate across the range of these species to identify any correlation between climate and population trends.

We will monitor the demography of individual beardtongue plants in permanent plots. Specifically, reproductive success will be quantified as the average number of seeds per fruit multiplied by the number of fruits per flower. In addition, we intend to monitor both pollinator abundance and diversity in the plots. Because it can be difficult to determine individual plants from clusters of plants growing together, we have decided to monitor frequency instead of density. Supplemental density will be measured in the demographic plots and will be compared to frequency after the pilot year. Frequency monitoring will also increase the efficiency of on the ground implementation. At least one random plot is located within one of the Red Butte Garden study populations. Additionally, the on-going long-term monitoring study of both species will continue on BLM managed lands in Colorado.

METHODS

Study Area

The study area comprises the entire ranges for both species (Figure 1). Study plot locations were randomly selected to represent the known range of conditions.

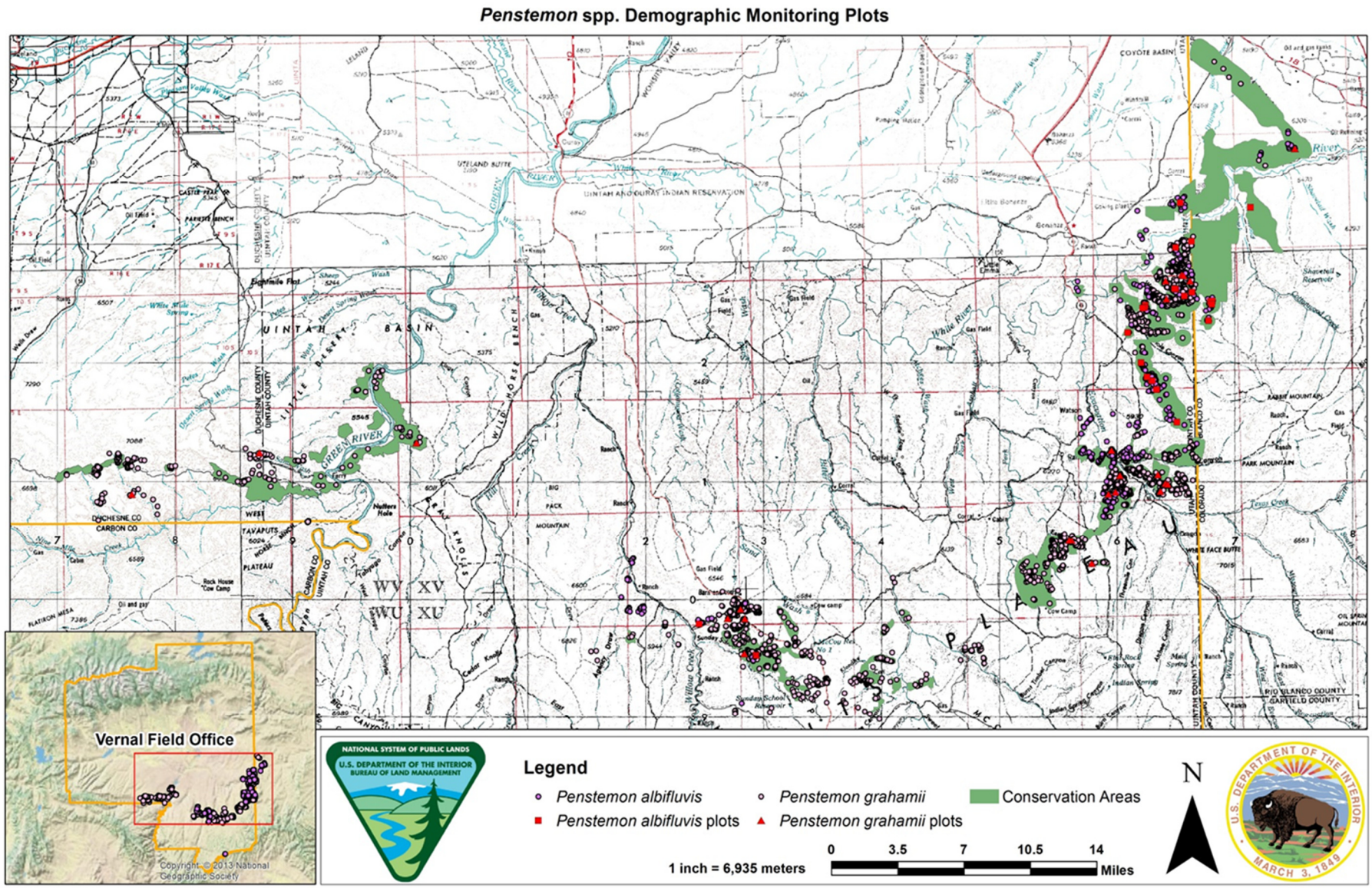

Figure 1. Penstemon demographic monitoring study area and plot locations.

Sample Units

A random sample of 25 monitoring plots for each species was generated using the "random points tool" in XToolsPro in ArcMap 10.3.1 (see Figure 1). Plots will be grouped into "sub-populations" based on proximity to each other to facilitate implementation, to help identify areas that may need management intervention, and to help with data analyses. Land ownership was not included in the selection process. If a private landowner objects to monitoring on their property, new plot locations will be selected from a backup set of randomly generated plots. Permanent monitoring plots will include a center demographic plot and three frequency transects extending out from the edges at random declinations spaced 120° apart (e.g. 0°, 120°, and 240°). Transect declinations can be adjusted as needed due to topographic constraints. Each center demographic plot will consist of a 1 m^2 quadrat placed around a randomly selected plant. Each transect will be 25 meters long and will be established 5 meters from the plot. Frequency will be measured, using 1x1, 1x2, and 2x2 meter nested frequency plots placed every 5 meters along each transect (Figure 2).

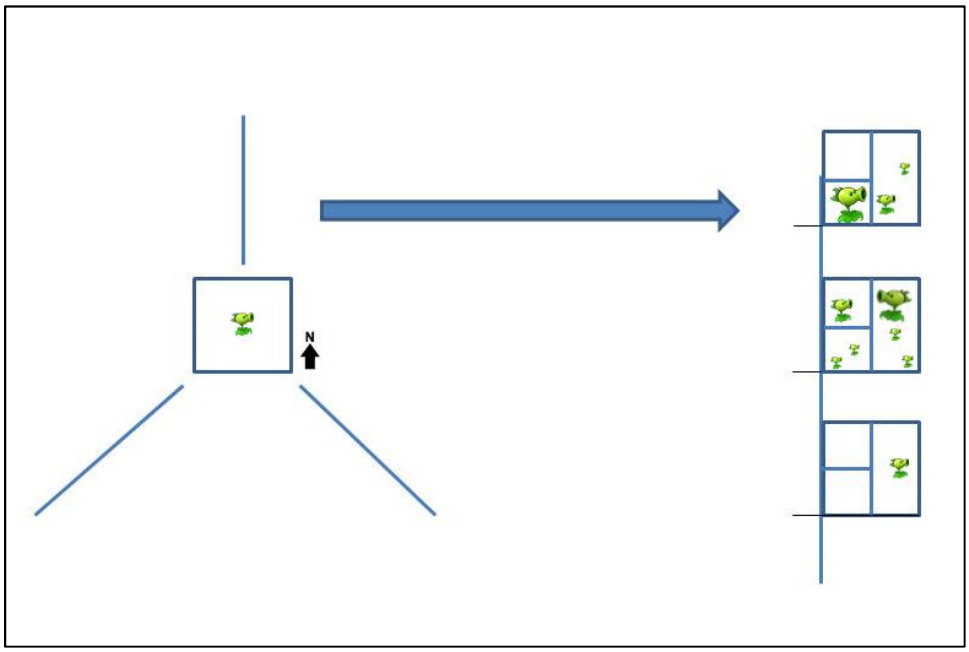

Figure 2. Penstemon monitoring study plot design.

Field Measurement Protocols

Phase one (Flowering):

1. Set up monitoring plots and transects:
    a. Locate and tag plants, plots are one square meter and oriented to magnetic north.
    b. Establish 25-meter transects (with GPS, monument end points) positioned five meters from the edge of the plot. The first transect declination will be determined randomly (using a random number generator). End points will be monumented with 10-inch aluminum nails and recorded with a GPS device with sub-meter accuracy.

c. Install at least 1 datalogger in occupied and 1 in unoccupied habitat from each of the five conservation area units.

2. Pollinator monitoring (Kearns and Inouye 1993)
    a. Watch tagged plant for 15 minutes (use timer)
    b. Count number of flower visitors by guild (i.e. bee, fly, butterfly, etc.) or by genus if possible (Lewinsohn and Tepedino 2004)
    c. Pollinators will be classified as observed visitors that enter a flower
3. Demographic Measures:
    a. Measures of plant size will follow methods in Dodge and Yates 2007 and will use digital calipers.
        i Rosette diameter (millimeters) for Graham's beardtongue
        ii Woody caudex diameter (millimeters) for White River beardtongue
    b. Number of flowers
    c. Number of buds (unopened flowers)
    d. Ratio of fruits to flowers (pollinator effectiveness)
    e. Counts of all rosettes/individuals in the plot
4. Frequency of plants along each transect:
    a. Frequency will be measured along the right side (when looking down transect from start) of transect only.
    b. A nested frequency quadrat (1x1, 1x2, and 2x2 meter) will be positioned every five meters along each transect, for a total of five nested quadrats per transect and 15 nested quadrats per monitoring plot.
    c. The number (frequency) of reproductive and non-reproductive individuals will be tallied in each nested quadrat. Seedlings will not be tallied because they are difficult to detect and identify to species.

Phase two (Fruiting):

1. The demographic plots will be revisited during fruiting and the following will be measured for each plant or cluster of plants:
    a. Total number fruits
    b. Seed counts from a subsample of fruits per plant (up to five fruits).
    c. Estimate number of seeds produced per plant by multiplying the average number of seeds per fruit by the total fruit count per plant.
    d. Estimate pollinator effectiveness as the total number of fruits divided by the total number of flowers on each plant.
    e. Counted seeds will be dispersed around the base of the study plant. Only seeds that appear healthy and full will be counted.

f. Seeds will be collected from up to 10% of the study population and will follow protocols outlined in the Penstemon Seed Collection Management Strategy.

Previous demographic studies have counted the seeds of these species for two years each (see Dodge and McDonough 2014 and Pavlik *et al.* 2015). To increase estimation accuracy for reproductive vital rates, seed counts should continue to be collected for at least three more years (5 years total).

Intended Data Analyses

Data will be analyzed using methods to be determined. We will look at differences in means and variances of the variables of interest between years. The following are the intended data analyses for each management objective.

1. Maintain the current range-wide population frequency of each beardtongue species so that overall frequency does not decrease by 10% or more over the next ten years.

    a. Plant frequency by stage class (i.e. reproductive and non-reproductive) will be compared between years and across years to determine long-term trends in population frequency.

    b. Mean density of rosettes (*P. grahamii*) and individuals (*P. albifluvis*) will be compared between years and across years to determine long-term trends in density.

2. Maintain the current pollinator abundance and diversity in at least 90% of all monitoring plots so that they do not decrease by 10% or more over the next ten years.

    a. Pollinator abundance and diversity will be followed over time and will be compared between years.

3. Determine overall trend(s) in reproductive success and do not allow a 30% decrease in reproductive success over any 3-year period.

    a. The reproductive measures number of seeds per fruit and the number of fruits per flower will be compared between years and across years.

    b. Pollinator effectiveness will be followed over time and compared between years.

4. Monitor climate data in beardtongue habitat.

    a. Temperature and humidity will be followed over time and correlations can be made between climate and demographic processes.

LITERATURE CITED

Dodge, R., and T. McDonough. 2014. 2014 Status Report Demographic Monitoring and Pollination Biology for *Penstemon scariosus* var. *albifluvis* and *Penstemon grahamii* in Uintah County, Utah. Bureau of Land Management, Utah State Office:34 pp.

Dodge, R., and W. Yates. 2007. 2007 Status Report Demographic Monitoring and Pollination Biology for *Penstemon scariosus* var. *albifluvis* and *Penstemon grahamii* in Uintah County, Utah. Bureau of Land Management, Utah State Office:19 pp.

Dodge, R., and W. Yates. 2009. 2009 Status Report Demographic Monitoring and Pollination Biology for *Penstemon scariosus* var. *albifluvis* and *Penstemon grahamii* in Uintah County, Utah. Bureau of Land Management, Utah State Office:27 pp.

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring & Monitoring Plant Populations. BLM Technical Reference 1730–1:496 pp.

Kearns, C. A., and D. W. Inouye. 1993. Techniques for Pollination Biologists. University Press of Colorado, Niwot.

Kearns, C. A., D. W. Inouye, and N. M. Waser. 1998. Endangered mutualisms: The conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics 29:83–112.

Lewinsohn, J., and V. Tepedino. 2004. 2004 Status Report on Demography and Pollinators for *Penstemon scariosus* var. *albifluvis* and *Penstemon grahamii* in Uintah County, Utah. Bureau of Land Management, Utah State Office:10 pp.

McCaffery, R. M., R. Reisor, K. Irvine, and J. Brunson. 2014. Demographic monitoring and population viability analysis of two rare penstemons from the Uinta Basin. Western North American Naturalist 74:257–274.

Pavlik, B., T. McDonough, and C. Cort. 2015. 2015 Status Report Demographic Monitoring and Pollination Biology for Penstemon scariosus var. albifluvis and Penstemon grahamii in Uintah County, Utah. Bureau of Land Management, Utah State Office:47 pp.

Penstemon Conservation Team. 2014. Conservation Agreement and Strategy for Graham's Beardtongue (*Penstemon grahamii*) and White River Beardtongue (*Penstemon scariosus* var. *albifluvis*). Prepared for the State of Utah School and Institutional Trust Lands Administration; Uintah County, Utah; Utah Public Lands Coordination Office; Utah Division of Wildlife Resources; Rio Blanco County, Colorado; Bureau of Land Management; and U.S. Fish and Wildlife Service. Prepared by SWCA Environmental Consultants, Salt Lake City, Utah: 86 pp.

Unnasch, R. S. 2009. Statistics Calculator. Sound Science LLC. http://sound-science.org.